REMARKS/ARGUMENTS

The undersigned thanks the examiner for discussing the office action by telephone on October 6, 2004 and the amendments and arguments submitted herewith.

It is requested that the finality of the office action be rescinded and the amendments entered since the amendments do not raise new issues and should put the application in order for allowance.

Claims 1, 2, 4-9 and 11-16 are pending in the application. Claims 6, 7, 13 and 14 have been allowed. Claims 3 and 10 were cancelled previously. Claims 1 and 8 are amended.

The amendment to claim 1 removes the reference to an analog delay since further review has led to the conclusion that it is an unnecessary limitation. In addition, in claims 1 and 8 the word "fixed" has been inserted before "capacitance equivalent ..." and the word "estimate" has been deleted (three occurrences). As discussed during the telephone interview, it was apparent from the original disclosure that the coupling element's capacitance was fixed but stating so explicitly in claim 1 avoids undesired interpretation. Likewise, the removal of the word "estimate" avoids any connotation that the signal passed by the coupling element is calculated or estimated in some way.

The amendments to the description are for consistency with amended claim 1.

In the office action, the examiner rejected claims 1 and 8 under 35 U.S.C. § 102(e) as anticipated by Overbury (US5,832,032); rejected claims 4 and 11 under 35 U.S.C. § 103 as unpatentable over Overbury in view of Felsberg *et al.* (US3,825,843); rejected claims 2 and 9 under 35 U.S.C. § 103 as unpatentable over Bingel *et al.* (US6,173,021) in view of Eaton *et al.* (US4,287,475) and further in view of OVerbury; and rejected claims 5, 12, 15 and 16 under 35 U.S.C. § 103 as unpatentable over Bingel *et al.* in view of Overbury in view of Felsberg and further in view Eaton. The rejections are respectfully traversed for the reasons set out below.

The present invention is concerned with noise in communications channels, for example telephone subscriber loops which, typically, are connected to a hybrid transformer which blocks DC currents flowing in the channel and propagates the communications signal by transformation. At normal operating frequencies, which are relatively low, the equivalent circuit of the hybrid transformer is primarily inductive, namely the self- and mutual-inductance of the primary and secondary windings. At high frequencies, however, the inductance can be ignored and the equivalent circuit is primarily capacitive, i.e., the stray capacitance coupling between the primary and secondary windings. Consequently, to some noise signals, such as impulse noise, which comprises very high frequencies, the hybrid transformer appears to be a complex capacitance, and the noise signals propagate through it substantially unimpeded.

The common mode signal is extracted from the channel prior to the hybrid transformer so, when the common mode noise estimator processes the common mode signal to estimate the interference and cancel it from the differential signal, it must take account of the noise which propagated across the stray coupling of the hybrid transformer.

Some radio frequency noise, such as interference from a neighbouring radio station, is relatively permanent and so can be cancelled using digital signal processing to compare the common mode signal with the differential signal and produce an error signal for use in adapting coefficients of an adaptive filter, the output of which is subtracted from the differential signal. This is the approach taken by Overbury in US5,832,032. Such an arrangement is not suitable, however, for cancelling impulse noise caused by switches or lightning. Impulse noise is of very short duration; so short that thc adaptive filter's coefficients could not be updated quickly enough to model and cancel it.

Recognizing this limitation, the present inventor resorted to the very simple expedient of coupling the common mode signal to the subtractor by means of a capacitance that, in essence, is an equivalent or model of the equivalent capacitance of the hybrid transformer and so will pass substantially the same impulse noise frequencies that the hybrid stray capacitance passed. It should be noted that no attempt is made to analyse or model the common mode noise signal. The present inventor simply took the view that, whatever portion of the impulse noise signal propagated across the input means (hybrid transformer), the capacitive coupling circuit, i.e., the capacitive equivalent circuit, would propagate the same. This resulted in a simple, cost-effective solution.

In preferred embodiments of the invention, the equivalent capacitance is obtained by simply short-circuiting a second hybrid transformer and using that to couple the common mode noise. The examiner has allowed claims 6 and 13 which are directed to the use of such a short-circuited hybrid transformer, but has rejected claims directed to what amounts to a direct equivalent, namely the use of a capacitive circuit instead of a short-circuited second hybrid transformer. It is possible to "synthesize" a hybrid transformer, i.e., replace it with circuitry that is functionally equivalent. Clearly, it is desirable to protect the invention as applied to such a situation, which is why applicant seeks protection for coupling the common mode noise by way of a coupling capacitance that is the equivalent of the stray capacitance of an input means which is not necessarily a transformer. It is submitted, therefore, that claims 1 and 8, which cover such equivalents, are patentable over Overbury along with claim 6.

Regarding the specific assertion by the examiner that Overbury anticipates claim 1 and 8,

it is submitted, with respect, that there is no support in the reference for this contention. It appears from the Office Action that the examiner may not have fully appreciated the import of the phrase "having a capacitance equivalent to stray capacitance coupling between an input and an output, ... of the input means... and may not have appreciated that Overbury's "weight" is not a capacitance. The phrase "the coupling means comprising a circuit element having a capacitance equivalent to stray capacitance coupling between an input and an output, respectively, of the input means,..." does not read onto Overbury's "weighted function that is made of complex components (i.e. capacitive) that adjust the phase and amplitude (i.e. effects of capacitive coupling) to match the differential signal component (figure 10, element 111 and column 5, line 55 through column 6, line 4)". Overbury does not show what is inside the box 90 (111 in Figure 10), but he gives an example in the paragraph beginning at column 6, line 6, as follows:

> "a pair of cascade arrangements of a local oscillator and a variable attenuator, the local oscillators being offset in quadrature. An input to the weight is fed to each local oscillator and an output from the weight is taken from each attenuator and summed."

While it is possible that an oscillator might involve discrete capacitors internally or in its control circuitry, a person skilled in this art would not consider a pair of local oscillators and attenuators to be (fixed) capacitive circuitry equivalent to the stray capacitance of the input means (hybrid transformer).

Overbury uses a weighting device 111 controlled by a weight control signal 89 produced by <u>three</u> digital processors 84, 86, 88. As described at column 5, lines 34 to 44, the processors 84 and 86 process the differential mode and local field (CM) signals (previously converted to digital) to produce respective processed outputs 85 and 87. The third processor 88 compares characteristics of the processed outputs 85 and 87 to derive the weight control signal, specifically using correlation. Hence, Overbury requires three digital signal processors, two performing FFT and the other performing correlation, to produce a weight control signal <u>to adjust</u> the weighting unit 90 to adjust the amount of the common mode signal subtracted from the differential signal.

The present invention does not adjust the coupling capacitance because it simply relies upon the fact that, whatever portion of the impulse noise signal couples across the stray capacitance of the input means (hybrid transformer), a similar amount will couple via the capacitive coupling circuitry because it is the equivalent of the stray capacitance coupling the input and the output.

Hence, Overbury does not disclose the features of claims 1 and 8 and the rejection under 35 U.S.C 102(e) is without substance.

It is noted that, in the section captioned Response to Arguments, the examiner stated that "The new limitation, **"a circuit element having a capacitance,"** is not any different than"**a capacitive component**"as originally claimed. There is a difference, however. In view of the comments made by the examiner in the first office action, it was concluded that the phrase "coupling means having a capacitive component equivalent to stray capacitance coupling between an input and output, respectively, of the input means,..." was capable of being interpreted as embracing some kind of "component" of a complex representation of Overbury's weight. The change to "circuit element having a capacitance equivalent to stray capacitance coupling between an input and an output, ..." was intended to preclude interpretation of the phrase in this way.

Claims 2, 4, 5, 9, 11, 12, 15 and 16 were rejected under 35 U.S.C. 103(a) as obvious in view of various combinations of the applied references, including Overbury.

The rejection is respectfully traversed.

It is desirable for a noise cancellation circuit to operate over a relatively wide band of frequencies. Claims 2 and 9 define a noise cancellation circuit which includes a "noise detector 50" which monitors the common mode signal, detects several frequency bands in which the common mode signal exceeds predetermined levels, and selects only those portions of the common mode signal for application to the adaptive filter 52 (see Fig. 3). Because only selected frequency bands are processed by the adaptive filter noise cancellation circuit, it can handle a greater bandwidth. Bingel *et al.* whether taken individually or in combination with Eaton and Overbury, neither disclose or suggest such an arrangement.

As the examiner noted on page 6 of the Office Action, Bingel does not have a noise detector which detects frequency bands of the common mode signal wherein noise exceeds a predetermined level and passes only those portions to the adaptive filter. Eaton *et al.* discloses a completely different and alternative technique, involving computation of a real time power spectrum of the input signal, which the skilled person would not consider trying to combine with Bingel's system. In fact, Eaton *et al.* would lead the skilled addressee away from using an adaptive filter noise cancellation circuit to achieve wide band performance. Thus, at column 1, lines 10-18, Eaton *et al.* state:

"The filtering of interference in prior art systems has been accomplished by: (1) fixed filters where the signal interference is know a priori; and (2) adaptive filters

where a single reference signal which is similar to the expected interference is known a priori. Neither technique is effective when the requirement to suppress unknown or changing interfering signals."

Hence, Eaton *et al.* would discourage the skilled addressee from even thinking of using an adaptive filter. Moreover, in the SUMMARY OF INVENTION section, Eaton *et al.* state that their system will

"perform a real time spectral analysis of the input signal, identifying the interfering signal or signals and remove the interference signals."

Thus, Eaton *et al.* process the whole spectrum to identify the interference and then remove it. In contrast, the present invention, as claimed in claim 2, simply detects the bands in which noise is above a certain threshold and selects those bands for noise cancellation. The adaptive filter does not even "see" the frequency bands in which the noise is below the threshold. This is different, conceptually, from Eaton *et al.*'s approach.

Since the skilled addressee would not be motivated or led to combine Bingel and Eaton *et al.*'s systems, it is irrelevant what Overbury teaches in regard to correlating the differential and common mode signals to derive a control signal for adjusting the weights of an adaptive filter.

As discussed above, Overbury uses two processors 84 and 86 to process the differential mode signal and common mode signal separately and then uses the third processor 88 to compare their characteristics, specifically by determining the ratio of the amplitudes of the signals at 105 and 108 (Figure 10), and their phase, and computing therefrom the complex weight. Overbury does not mention or suggest selecting and processing only portions of the common mode signal in different frequency bands where the common mode signal exceeds a predetermined level.

Accordingly, claims 2 and 9 are patentable over the cited references.

Impulse noise tends to be very short duration but relatively large amplitude. For an analog-to-digital converter to convert the impulse noise signal, it would have to have such an extensive dynamic range that it would not be able to convert other signals. Hence, other interference signals would appear to be zero. Conversely, the analog-to-digital might be saturated by the impulse signal. The invention claimed in independent apparatus claim 15 and independent method claim 16 addresses this problem by cascading the impulse noise cancellation circuit of claim 1 with an adaptive filter circuit. The impulse noise cancellation circuit removes the impulse noise before the signal is applied to the analog-to-digital converter of the subsequent adaptive filter noise cancellation circuit. This avoids saturation of the analog-to-digital converter in the latter. Neither Bingel *et al.* nor Overbury disclose or suggest using an analog cancellation

circuit and a digital cancellation circuit in tandem, the former to cancel impulse noise and the latter to cancel the remaining noise.

The examiner acknowledged that Bingel does not disclose the use of two cancellation paths in tandem. He asserted, however, that, "In order to prevent the differential signal from overloading ADCs (column 1, lines 50-54) in the differential signal path, Overbury couples an analog RFI canceller system between the differential input means and a (sic) analog-to-digital converter (figure 10)." (emphasis added). The present invention, however, is not concerned about the ADCs in the differential path; it is concerned with overloading ADCs in the common mode path, specifically in a digital noise cancellation circuit. It addresses the problem by using two noise cancellation circuits in series or tandem, both in the common mode path. Overbury does not contemplate such a solution and would not lead the skilled addressee to it. Consequently, claim 15 is patentable over the applied refenences.

Moreover, claim 15 includes the subject matter of claims 1 and 2, so it is also patentable for the reasons advanced above in relation to those claims.

Method claim 16 corresponds to claim 15 and so is patentable for the same reasons.

Claims 4, 5, 11 and 12, being dependent upon claims 1,15, 8 and 16, respectively, incorporate the features of those claims and so are patentable with them.

In view of the foregoing, it is submitted that all claims or record are patentable over the cited references and early and favourable reconsideration of the application is respectfully requested.

Respectfully submitted,

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Date

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